



Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat- Exchanger, and Condenser Tubes¹

This standard is issued under the fixed designation A 249/A 249M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—The value for “SX” in Paragraph S9.4 was editorially corrected to “S9” in June 1999.

1. Scope

1.1 This specification² covers nominal-wall-thickness welded tubes made from the austenitic steels listed in Table 1, with various grades intended for such use as boiler, superheater, heat exchanger, or condenser tubes.

1.2 Grades TP304H, TP309H, TP309HCb, TP310H, TP310HCb, TP316H, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP309S, TP309Cb, TP310S, TP310Cb, TP316, TP321, TP347, and TP348, and are intended for high-temperature service such as for superheaters and reheaters.

1.3 The tubing sizes and thicknesses usually furnished to this specification are ⅜ in. [3.2 mm] in inside diameter to 5 in. [127 mm] in outside diameter and 0.015 to 0.320 in. [0.4 to 8.1 mm], inclusive, in wall thickness. Tubing having other dimensions may be furnished, provided such tubes comply with all other requirements of this specification.

1.4 Mechanical property requirements do not apply to tubing smaller than ⅜ in. [3.2 mm] in inside diameter or 0.015 in. [0.4 mm] in thickness.

1.5 Optional supplementary requirements are provided and, when one or more of these are desired, each shall be so stated in the order.

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.

1.7 The following safety hazards caveat pertains only to the test method described in the Supplementary Requirements of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. A specific warning statement is given in Supplementary Requirement S7, Note upp.

2. Referenced Documents

2.1 ASTM Standards:

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels³

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes⁴

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip³

E 112 Test Methods for Determining Average Grain Size⁵

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing⁶

E 273 Practice for Ultrasonic Examination of Longitudinal Welded Pipe and Tubing⁶

E 527 Practice for Numbering Metals and Alloys (UNS)⁴

3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Name of material (welded tubes).

3.1.3 Grade (Table 1),

3.1.4 Size (outside diameter and nominal wall thickness),

3.1.5 Length (specific or random),

3.1.6 Optional requirements (13.6),

3.1.7 Test report required (see Certification Section of Specification A 450/A 450M),

3.1.8 Specification designation, and

3.1.9 Special requirements and any supplementary requirements selected.

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Steel Tubing.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-249 in Section II of that Code.

³ Annual Book of ASTM Standards, Vol 01.03.

⁴ Annual Book of ASTM Standards, Vol 01.01.

⁵ Annual Book of ASTM Standards, Vol 03.01.

⁶ Annual Book of ASTM Standards, Vol 03.03.



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TABLE 1 Chemicals Requirements, %

Grade	Composition, %															
	TP 201	TP 202	TP 304	TP 304H	TP 304L	TP 304N	TP 304LN	TP 305	TP 309Cb	TP 309H	TP 309HCB	TP 309S	TP 310Cb	TP 310H	TP 310HCB	TP 310S
UNS Designation ^A	S20100	S20200	S30400	S30409	S30403	S30451	S30453	S30500	S30940	S30909	S30941	S30908	S31040	S31009	S31041	S31008
Carbon	0.15 max	0.15 max	0.08 max	0.04– 0.10	0.035 max ^B	0.08 max	0.035 max ^B	0.12 max	0.08 max	0.04– 0.10	0.04 0.10	0.8 max	0.08 max	0.04– 0.10	0.04– 0.10	0.08 max
Manganese, max ^C	5.50– 7.50	7.50– 10.0	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Phosphorus, max	0.060	0.060	0.040	0.040	0.040	0.040	0.040	0.045	0.045	0.040	0.045	0.045	0.045	0.040	0.045	0.045
Sulfur, max	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
Silicon, max	1.00	1.00	0.75	0.75	0.75	0.75	0.75	1.00	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Nickel	3.50– 5.50	4.00– 6.00	8.00– 11.0	8.00– 11.0	8.00– 13.0	8.00– 11.0	8.00– 13.0	10.0– 13.0	12.0– 16.0	12.0– 15.0	12.0– 16.0	12.0– 15.0	19.0– 22.0	19.0– 22.0	19.0– 22.0	19.0– 22.0
Chromium	16.0– 18.0	17.0– 19.0	18.0– 20.0	18.0– 20.0	18.0– 20.0	18.0– 20.0	18.0– 20.0	17.0– 19.0	22.0– 24.0	22.0– 24.0	22.0– 24.0	22.0– 24.0	24.0– 26.0	24.0– 26.0	24.0– 26.0	24.0– 26.0
Molybdenum	...	...	...	...	...	...	...	...	0.75 max	...	0.75 max	0.75 max	0.75 max	...	0.75 max	0.75 max
Titanium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Columbium + tantalum	...	...	...	...	...	...	...	...	10 × C min 1.10 max	...	10 × C min 1.10 max	...	10 × C min 1.10 max	...	...	...
Tantalum, max	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Nitrogen ^D	0.25 max	0.25 max	...	...	...	0.10– 0.16	0.10– 0.16	...	...	...	...	...	...	...	...	0.10– 0.16
Vanadium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Others	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE 1 *Continued*

Grade	Composition, %																							
	TP 317	TP 317L	TP 321	TP 321H	TP 347	TP 347H	TP 348	TP 348H	XM-15	TP XM-19	TP XM-29	S30615	S31050	S31254	S30815	D31725	S31726	S24565	S33228	S30415	S32654	N08367	N08926	N08904
UNS Designation	S31700	S31703	S32100	S32109	S34700	S34709	S34800	S34809	S38100	S20910	S24000	S30615	S31050	S31254	S30815	D31725	S31726	S24565	S33228	S30415	S32654	N08367	N08926	N08904
Carbon	0.08 max	0.035 max	0.08 max	0.04–0.10	0.08 max	0.04–0.10	0.08 max	0.04–0.10	0.08 max	0.06 max	0.08 max	0.16–0.24	0.025 max	0.02 max	0.05–0.10	0.03 max	0.03 max	0.03 max	0.04–0.08	0.04–0.06	0.020 max	0.030 max	0.020 max	0.020 max
Manganese, max ^C	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	4.00–6.00	11.5–14.5	2.00	2.00	1.00	0.80	2.00	2.00	5.0–7.0	1.0	0.80	2.00–4.00	2.00 max	2.00 max	2.00
Phosphorus, max	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.020	0.03	0.04	0.045	0.045	0.030	0.020	0.045	0.030	0.040 max	0.03	0.045
Sulfur, max	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.015	0.01	0.03	0.03	0.03	0.010	0.015	0.030	0.005	0.030	0.01	0.035
Silicon, max ^C	0.75 max	0.75 max	0.75 max	0.75 max	0.75 max	0.75 max	0.75 max	0.75 max	1.50–2.50	1.00 max	1.00 max	3.2–4.0	0.4 max	0.80 max	1.40–2.00	0.75 max	0.75 max	1.00 max	0.30	1.00–2.00	0.50 max	1.00 max	0.5	1.00
Nickel	11.0–14.0	11.0–15.0	9.00–13.0	9.00–13.0	9.00–13.0	9.00–13.0	9.00–13.0	9.00–13.0	17.5–18.5	11.5–13.5	2.25–3.75	13.5–16.0	20.5–23.5	17.5–18.5	10.0–12.0	13.5–17.5	13.5–17.5	16.0–18.0	31.0–33.0	9.00–10.00	21.0–23.0	23.50–25.50	24.00–26.00	23.0–28.0
Chromium	18.0–20.0	18.0–20.0	17.0–20.0	17.0–20.0	17.0–20.0	17.0–20.0	17.0–20.0	17.0–20.0	17.0–19.0	20.5–23.5	17.0–19.0	17.0–19.5	24.0–26.0	19.5–22.0	20.0–22.0	18.0–20.0	17.0–20.0	23.0–25.0	26.0–28.0	18.0–19.0	24.0–25.0	20.00–21.00	19.00–21.00	19.0–23.0
Molybdenum	3.00–4.00	3.00–4.00	...	...	...	...	...	...	...	1.50–3.00	...	...	1.6–2.6	6.00–6.50	...	4.0–5.0	4.0–5.0	4.0–5.0	...	...	7.00–8.00	6.00–7.00	6.0–7.0	5.0
Titanium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Columbium + tantalum	...	...	...	...	...	...	...	...	...	0.10–0.30	...	...	...	...	...	...	...	0.1 max	0.6–1.0	...	...	...	...	...
Tantalum, max	...	...	...	...	...	...	0.10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Nitrogen ^D	...	...	...	...	...	...	...	...	...	0.20–0.40	0.20–0.40	...	0.09–0.15	0.18–0.22	0.14–0.20	0.10 max	0.10–0.20	0.4–0.6	...	0.12–0.18	0.45–0.55	0.18–0.25	0.15–0.25	0.10 max
Vanadium	...	...	...	...	...	...	...	...	...	0.10–0.30	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Others	...	...	...	...	...	...	...	...	...	...	...	Al 0.8–1.5	Cu 0.50–1.00	Ce 0.03–0.08	Cu 0.75 max	Cu 0.75 max	Cu 0.75 max	...	Ce 0.05–0.10	Cu 0.30–0.60	Cu 0.75 max	Cu 9.5–15	Cu 1.0–2.0	

^A New designation established in accordance with Practice E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

^B For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in Grades TP 304L and TP 316L. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall are those less than 0.049 in. [1.2 mm] in average wall thickness (0.044 in. [1.1 mm] in minimum wall thickness).

^C Maximum, unless otherwise indicated.

^D The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.

^E Grade TP 321 shall have a titanium content of not less than five times the carbon content and not more than 0.70 %.

^F Grade TP321H shall have a titanium content of not less than four times the carbon content and not more than 0.60 %.

^G Grades TP 347 and TP348 shall have a columbium plus tantalum content of not less than ten times the carbon content and not more than 1.0 %.

^H Grades TP 347H and TP 348H shall have a columbium plus tantalum content of not less than eight times the carbon content and not more than 1.0 %.